Malaviya National Institute of Technology Jaipur
Mechanical Engineering Department

Syllabus for PhD Entrance Exam (Design Engineering)

Mechanics of Materials - Equation of Motion, Symmetry of Stress Tensor, Transformation of Stresses, Principal Stresses, Principal Directions, Strain, Rotations, Compatibility Equations, St. Venant's Principle and Principle of Uniqueness, Airy Stress function, Elastic constants, Virtual Work, Castigliano Theorems, thin cylinders, Mohr's circle, plane stress and plane strain problems in rectangular and polar coordinates, bending of slender straight and curved beams, deflection of beams, bending and shear stresses, plate with and without hole, torsion of circular, elliptical and rectangular shafts, energy methods, Euler's theory of columns, thermal stresses, testing of materials with universal testing machine, strain gauges and rosettes, testing of hardness and impact strength,

Engineering Mechanics - Trusses and frames; free body diagrams and equilibrium, virtual work; impulse and momentum (linear and angular), kinematics and dynamics of particles & of rigid bodies in plane motion and energy formulations, collisions.

Theory of Machines - Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of linkages; cams; gears and gear trains; flywheels and governors; balancing of reciprocating and rotating masses; gyroscope and Design of Mechanisms

Machine Design - Design for static and dynamic loading, Failure theories, concepts of Fracture mechanics, fatigue strength and the S-N diagram, gears, shafts, rolling and sliding contact bearings, springs, brakes and clutches, principles of the design of machine elements like riveted, bolted and welded joints, Design methods, Material Selection

Vibrations - Fundamentals of Vibration: Vibration Analysis Procedures, Harmonic analysis, Free and Forced Vibration analysis of single degree of freedom system, Stability conditions, Methods of analysis, single degree of freedom systems with viscous, Coulomb and Hysteresis damping, Vibration under general forcing conditions. Two Degree Freedom System: Introduction-Free and Forced Vibration Analysis of Undamped and Damped Systems, Bending Vibration of Two Degrees of Freedom System, Coordinate Couplings And Principal Coordinates, Stability Analysis. Multi-Degree Freedom System and Continuous System: Generalized Coordinates and Generalized Forces, Lagrange's Equation, Eigen Value Problem, Orthogonality of Mode Shapes, Modal Analysis, Forced Vibration using Modal Analysis. Continuous Systems: Transverse Vibration of a String or Cable, Longitudinal Vibration of a Bar or Rod, Torsional Vibration of a Shaft or Rod, Lateral Vibration of Beams Vibration Control: Vibration Isolation, Vibration Absorbers, Vibration Control by Design Modification,, Vibration as condition Monitoring tool Vibration Measurement and Applications: Transducers,

Vibration Exciters, Vibration Measuring Instruments, Signal Analysis, Experimental Modal Analysis, Machine Condition Monitoring and Diagnosis.

Engineering Mathematics: *Differential equations* - Linear and nonlinear, Euler-Cauchy equation; higher-order linear differential equations with constant coefficients, initial and boundary value problems; solutions of heat, wave and Laplace's equations; Laplace transforms. *Calculus* - Evaluation of definite and improper integrals; Functions of single variable, limit, continuity and differentiability, mean value theorem, indeterminate forms; double and triple integrals; total derivative, partial derivatives, maxima and minima, Taylor series (in one and two variables), Fourier series; divergence and curl, gradient, vector identities, line, directional derivatives, surface and volume integrals, and Green’s theorems and applications of Gauss, Stoke.

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Design Engineering (Model questions)

Q1. The critical speed of a rotating shaft depends upon
a). mass
b.) stiffness
c.) mass and stiffness
d.) mass, stiffness and eccentricity

Q2. In a simple bending theory, one of the assumption is that the material of the beam is isotropic. This assumption means that the
(a). normal stress remains constant in all directions
(b). Elastic Constants are same at all points in the material
(c). elastic constants are same in all the directions
(d). elastic constants varies linearly in the material

Q3. Tensile strength of a mild steel specimen can be roughly predicted from following hardness test
(a) Brinell
(b) Rockwell
(c) Vicker
(d) Shore's sceleroscope

Q4. When two spur gears having involute profiles on their teeth engage, the line of action is tangential to the

a.) Pitch circles
b.) Dedendum circles
c.) Addendum circles
d.) Base circles